**9th International Command and Control Research and Technology Symposium**

**Coalition Transformation: An Evolution of People, Processes, and Technology to Enhance Interoperability**

**Topic: C2 Experimentation**

# Title: Human Systems Integration Assessment of Network Centric Command and Control

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**ABSTRACT**. Trident Warrior 2003 (TW03) was a Navy initiative to demonstrate an initial baseline of potential FORCEnet capabilities. FORCEnet is the operational construct and architectural framework for Naval Network Centric Warfare in the information age that integrates warriors, sensors, networks, command and control, platforms, and weapons into a distributed combat force. TW03 provided an integrated prototype capability for fleet evaluation and refinement of a supportable incremental delivery of FORCEnet capability. The Chat system was limited by the synchronous nature of the system that required constant attention to monitor communications, by the number of participants that could be accommodated and recognized, and by the time required for users to authorize, compose, and type messages. The connections between the fire control systems allowed users to share common situation awareness on tracks, targets, and fire schedules but were mediated by the GCCS-M position information, which could lag up to 15 minutes behind real-time. The utility of the links between the fire support systems were limited by the inability of one system to accommodate the same target designations from another system and by the lack of connection between systems. Situation awareness is a continuing process and the limitation of reliance on chat as a status indicator was highlighted when one shooter was not aware that he was supposed to be in position to provide fire support to shore. Chat technology was used extensively to transfer information among distributed teams. Confusions and missed messages were noted occasionally and were typically due to user interface design problems, ambiguous operating procedures, or technical incompatibilities between chat systems. Display configurations and workspace layouts were problematic and led to inefficiencies in the way that information was transferred within and between command centers. Consideration of the proper location of operator workstations, legibility of shared displays, and easy access to task-relevant information would improve operations. While training was available on how to operate individual FORCEnet systems, little instruction was provided concerning how to employ the systems for maximal operational effectiveness. eated insufficient manpower for the new systems, limited their usefulness and adaptability. HSI is an important consideration in FORCEnet systems analysis and assessment. FORCEnet systems rely upon the performance of human operators and/or maintainers, despite their level of automation. Therefore, HSI issues need to be examined along with the technical aspects of the systems themselves as part of the total systems engineering approach.

**INTRODUCTION**. Trident Warrior 2003 (TW03) was a Navy initiative to demonstrate an initial baseline of potential FORCEnet capabilities. FORCEnet is the operational construct and architectural framework for Naval Network Centric Warfare in the information age that integrates warriors, sensors, networks, command and control, platforms, and weapons into a distributed combat force. TW03 provided an integrated prototype capability for fleet evaluation and refinement of a supportable incremental delivery of FORCEnet capability.

The TW03 FORCEnet capabilities supported operational objectives in the following areas:

(a) Expeditionary, multi-tiered weapon and sensor information (Call For Fires),

(b) Distributed, collaborative command and control (C2 / Collaboration), and

(c) Dynamic, multi-path and survivable networks (Network Operations).

This paper presents major HSI issues that were identified through the analysis of field performance data.

**FORCENET PROCESSES AND TECHNOLOGIES**

***Call For Fires.*** Call For Fires furnished a context for assessing the new form of C2 advocated by FORCEnet. Call For Fires entails a coordinated effort to identify, validate, and verify a potential target for fire. A major concern during Call For Fires activities is to confirm that the target is hostile, so as to prevent friendly fire casualties. To achieve its objectives, Call For Fires requires the coordinated use of three technologies: Automated Deep Operations Coordination System (ADOCS), Advanced Field Artillery Tactical Data System (AFATDS), and Naval Fire Control System (NFCS).

***Command and Control/Collaboration.*** Command and control was integral to all TW03 activities. It consisted of capabilities that facilitated decision making, such as acquiring and maintaining situation awareness and a common operational picture. Collaboration enables the sharing of information among persons working on a common task or project. The collaborative technologies implemented for TW03 were intended to supply real-time communication among geographically separated individuals and groups. Several technologies were used that enabled participants to acquire and maintain a shared awareness of the battlespace: FORCEview, Global Command and Control System–Maritime (GCCS-M), Task Force Web (TFW), Web Common Operational Picture (WebCOP), and Collaboration Tools (Chat and MS NetMeeting)

***Network Operations.*** Network Operations refer to establishing, operating, and maintaining information technology (IT) networks that support the activities of TW03. Hardware is the primary focus of Network Operations; the four technologies that were used during TW03 – Automated Digital Network Switch (ADNS), HF ALE, Intra-Battle Group Wireless Network (IBGWN), and Super High Frequency / Commercial Wideband Satellite Program (SHF/CWSP) – did not require ongoing user input. Information management personnel monitored the networks and serviced them as needed throughout TW03. The Network Operations data collected during TW03 centered on two activities: bringing the technology online and maintaining its function.

**HUMAN SYSTEMS INTEGRATION (HSI) IN NAVAL OPERATIONS.** HSI is a comprehensive management and technical strategy to integrate human considerations early in the

system design, development, and demonstration process. HSI plays an important role in efforts to create systems that accommodate human sensory, perceptual, cognitive, and physical performance characteristics. Its major goals are to improve total system performance and reduce costs of ownership.[1] Failure to take HSI into account during system design and implementation typically results in systems that are difficult to learn and operate reliably and efficiently. HSI accomplishes its goals by considering seven elements associated with system design, development, and implementation: manpower, personnel, training, human factors engineering, safety, health hazards, and survivability. Together, these elements define how human users affect a system (in terms of effectiveness, operation, and support and their associated costs) and how a system affects the humans who interact with it (e.g., operators, maintainers, supporters, trainers). Although each element is important, Human Factors Engineering has primary responsibility for establishing HSI human performance objectives, thresholds, and characteristics. This, plus manpower, personnel, and training, are the primary areas of HSI analysis for IT systems, such as FORCEnet.

**FOCUS AREAS FOR HSI ANALYSIS.** In order to assess the three FORCEnet processes (Call For Fires; C2 / Collaboration; Network Operations) and their component technologies during TW03, it is necessary to define HSI analysis goals.

An overarching goal of the HSI assessment in TW03 was to improve the kill chain. Technology and the warfighter are the two major elements in the kill chain that provide the greatest opportunity to accelerate the decision and fire control process from the initial stages of target detection to follow-up damage assessments. Improving the kill chain depends on effective HSI among FORCEnet capabilities and improved organizational processes and procedures. Four areas have been identified as primary attributes of warfighting effectiveness and served as focus areas for HSI analysis in TW03:

- **Shared Awareness**. A common perception and understanding of the tactical battlespace and of the roles, responsibilities, and actions of other warfighters.
- **Efficiency of Asset Utilization**. Length of time needed to assign an asset, time needed to complete a mission, number of tasks accomplished.
- **Speed of Command**. Time from when an event occurred until the ordered action was completed.
- **Adaptability**. The extent and speed of an organization's change in response to changing tactical situations.

To define these warfighting attributes in terms of human performance variables that could be measured during TW03, five HSI analytic elements were used:

- **Performance**. The performance variable assessed shared awareness and speed of command. Performance evaluations were based on three types of performance data

[1] Department of Defense (January 2001). *Glossary: Defense Acquisition Acronyms and Terms* (10th ed.). Department of Defense, Defense Systems Management College. Fort Belvoir, VA.

collected from TW03 participants during and after task performance: situation awareness, accuracy, and latency (time to perform).

- **User interface**. Experienced human factors usability analysts conducted user interface evaluations based on human factors usability heuristics. These evaluations supplemented the performance-based data with more detailed analytic information. The results of these evaluations are relevant to efficiency of asset utilization, shared awareness, and speed of command.
- **Information transfer**. The extent to which information needed to operate each technology in its intended manner as well as to achieve mission goals was assessed. This variable is related to shared awareness and speed of command.
- **Training**. Training assessments were performed to determine the type and extent of instruction needed to operate each technology effectively, efficiently, and safely; training is primarily related to adaptability to changing conditions.
- **Manpower and personnel**. Manpower and personnel requirements for the proper operation and maintenance of each technology were determined to the extent possible during TW03. This variable is primarily related to efficiency of asset utilization.

Together, these five HSI elements furnished the foundation needed to formulate and implement an analytic plan that enabled meaningful HSI assessments of the technological systems used during TW03 in support of FORCEnet objectives.

**ASSESSMENT OF HSI PROCESSES.** HSI observers were embarked onboard two ships as part of an Expeditionary Strike Group (ESG) prior to and during TW03. They collected data during key events related to (a) expeditionary, multi-tiered weapon and sensor information in the 'call-for-fire' process, (b) distributed, collaborative command and control, and (c) dynamic, multi-path and survivable networks.

HSI data were collected using a range of methods, including questionnaire ratings by FORCEnet users, interviews with operators, observations by HSI experts of operational performance and system administration, training effectiveness analysis, and usability analyses of FORCEnet software and workspace ergonomics.

**HSI FINDINGS.** The following table summarizes the FORCEnet operational processes analyzed during Trident Warrior 2003 in terms of major elements in Human Systems Integration (HSI )[2]:

| HSI Process | HSI Element | | | | |
|---|---|---|---|---|---|
| | Performance | User Interface | Information Transfer | Training | Manpower & Personnel |
| Call For Fires | G | G | Y | Y | Y |
| C2 / Collaboration | Y | Y | Y | Y | G |
| Network Operations | G | | | Y | |

**DISCUSSION**. Individuals in the battle group are often isolated and must actively collect and share information to coordinate their actions. Coordination information was passed between distributed individuals via direct linkages between the fire support systems (ADOCS, AFATDS, NFCS, GCCS) and by way of collaboration tools (Chat, NetMeeting). The Chat system was limited by the synchronous nature of the system that required constant attention to monitor communications, by the number of participants that could be accommodated and recognized, and by the time required for users to authorize, compose, and type messages. The connections between the fire control systems allowed users to share common situation awareness on tracks, targets, and fire schedules but were mediated by the GCCS-M position information, which could lag up to 15 minutes behind real-time.

The utility of the links between the fire support systems were limited by the inability of AFATDS to accommodate the same target designations as ADOCS and by the lack of connection between the NFCS and the shooters weapon systems. These problems were circumvented by the operators who entered incorrect data into the systems that allowed the support systems to be used locally, but had the unfortunate result of sharing the incorrect data with other members of the CFF chain who then assumed that specified targets had not been engaged and issued redundant engagement orders.

Situation awareness is a continuing process and the limitation of reliance on chat as a status indicator was highlighted when one shooter was not aware that he was supposed to be in position to provide fire support to shore. Design of a tool that provides support to users in the form of process status indicators that augment the collaborative message content would help avoid some of these situation awareness problems.

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[2] G Fully functional. Meets requirements but can be improved with minor modifications.
Y Functional but requires substantial modifications.
Inadequate data were available for valid assessment.

Chat technology was used extensively to transfer information among distributed teams. Confusions and missed messages were noted occasionally and were typically due to user interface design problems, ambiguous operating procedures, or technical incompatibilities between chat systems.

Display configurations and workspace layouts were problematic and led to inefficiencies in the way that information was transferred within and between command centers. Consideration of the proper location of operator workstations, legibility of shared displays, and easy access to task-relevant information would improve operations.

Engagement timelines for four CFF events have been reconstructed from ADOCS electronic logs, IRC chat logs and observer notes. The reconstructed timelines for these 4 CFF events show execution times from 31 to 230 minutes. The 230-minute response was a difficult target with high potential for collateral damage. But the timing suggests that the distributed CFF task performers did not realize that the window for engagement had passed or that a potential blue-on-blue situation might have occurred between the NLT and actual fires.

Another speed of command issue related to the information passed between members of the distributed fire support team was noted when the fire planning was completed and de-conflicted, but the TAO's involvement in adapting to a lost chat link prevented him from authorizing a pending CFF. The interconnections between the fire support systems (AFATDS-NFCS-ADOCS-GCCS) provided the potential to execute the fires scenarios much more safely and rapidly, but were not complete enough to pass all the information required to automate the CFF process (AFATDS did not recognize TGTD target nominations, and NFCS was not connected to the shooter's weapons).

While training was available on how to operate individual FORCEnet systems, little instruction was provided concerning how to employ the systems for maximal operational effectiveness. Because of the concurrent events during TW03, trained operators and maintainers were quite limited for most FORCEnet systems. This created insufficient manpower for the new systems, limited their usefulness and adaptability.

**CONCLUSIONS**. HSI is an important consideration in FORCEnet systems analysis and assessment. FORCEnet systems rely upon the performance of human operators and/or maintainers, despite their level of automation. Therefore, HSI issues need to be examined along with the technical aspects of the systems themselves as part of the total systems engineering approach. Specific HSI issues were identified for FORCEnet technologies and for their integration with legacy systems and procedures. Many of the FORCEnet technologies functioned well in TW03, but several areas for potential HSI enhancements were uncovered during the exercise.

Structured exercise test procedures are needed to permit collecting quantitative human performance data, including situation awareness, decision latency, and workload. HSI data collection and analysis was constrained by the diverse and often competing objectives of TW03, by the unstable introduction of scenario events / MSELs, and by the uncertainty about how the technologies would be used. Efforts to address these methodological issues earlier during exercise planning would permit much greater precision in the HSI data collected.

SPAWAR

055

HSI

# Human Systems Integration Assessment of Network Centric Command and Control


**9th International Command and Control Research and Technology Symposium**
**Copenhagen, Denmark**
**September 14-16, 2004**

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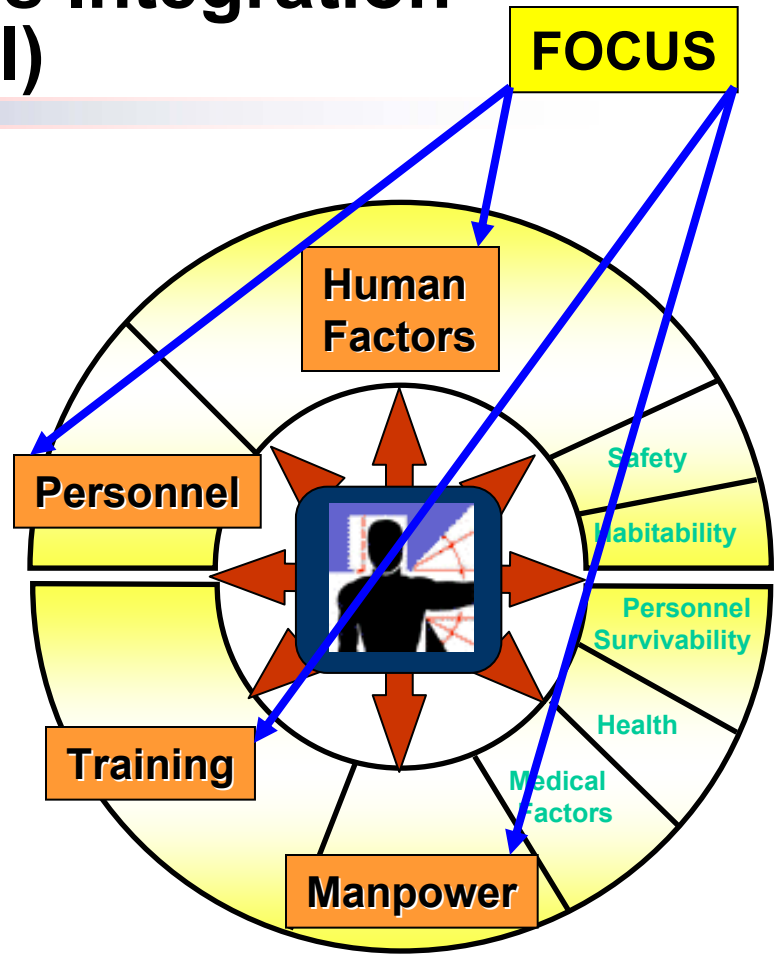
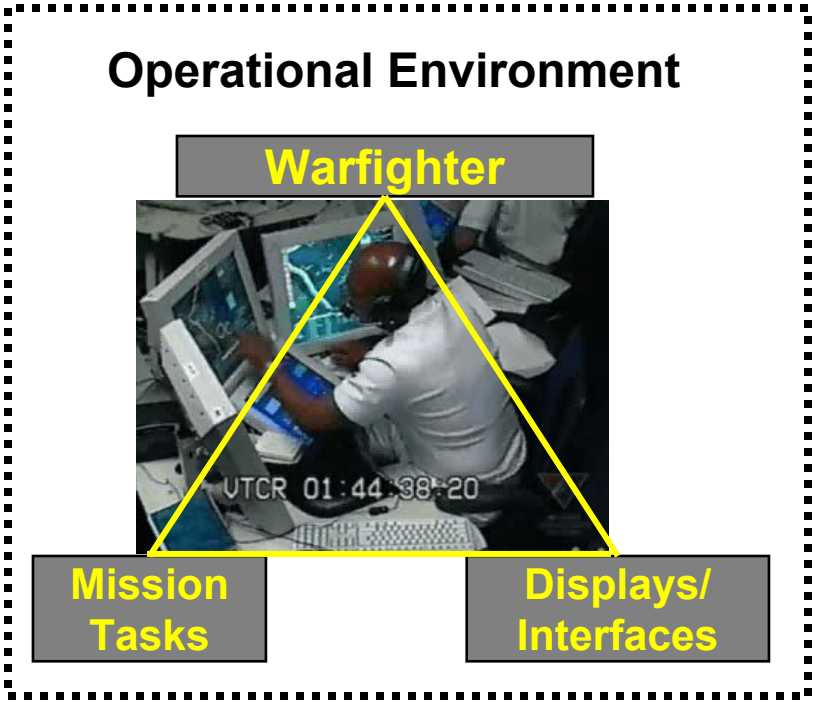
**Space and Naval Systems Command**
**Richard T. Kelly**
**Pacific Science and Engineering**

# Human Systems Integration (HSI)

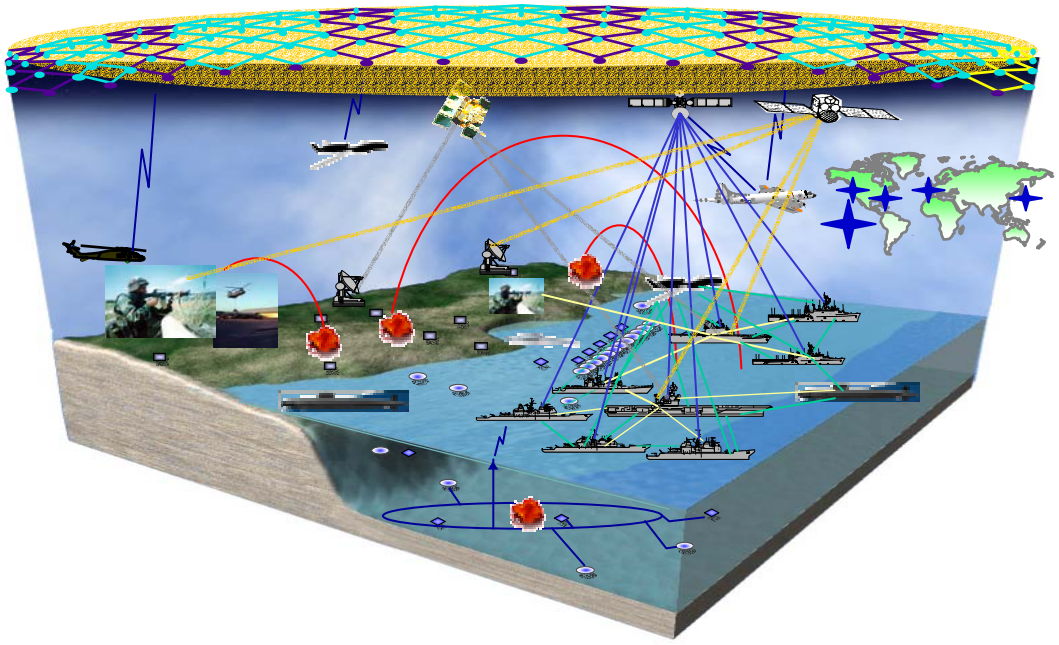
- Integrates human capabilities and limitations into system definition, design, development, and evaluation to optimize human-system performance under operational conditions




- Part of <u>total systems engineering</u> approach to analysis, design, development, and test of a product or system

# US Navy Network Centric Warfare (NCW): FORCEnet



***"FORCEnet is the operational construct and architectural framework for Naval Warfare in the Information Age which integrates WARRIORS, sensors, networks, command and control, platforms and weapons into a networked, distributed combat force, scalable across the spectrum of conflict from seabed to space and sea to land." ****

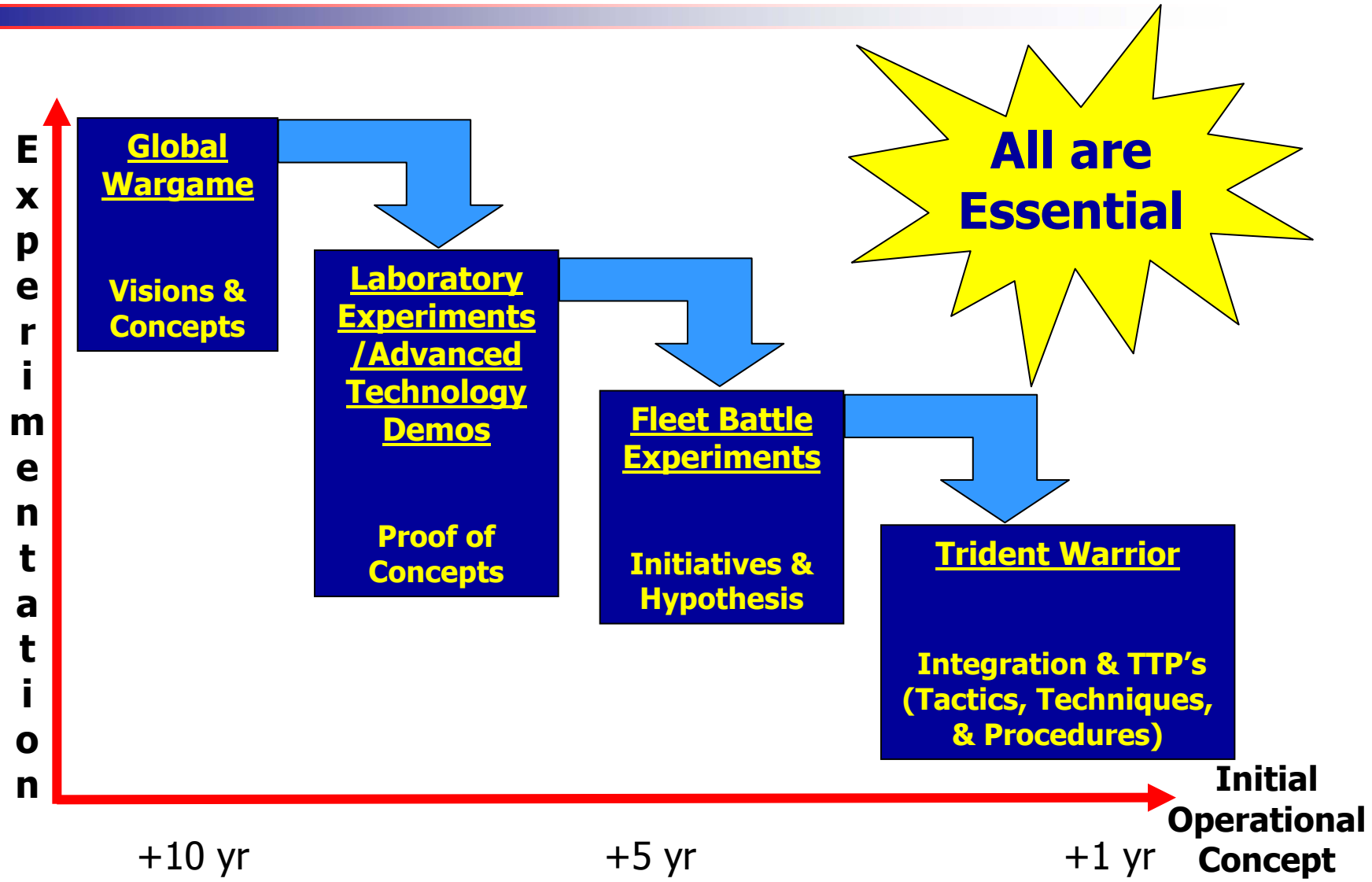
* CNO's Strategic Study Group – XX definition from 22 July 02 CNO Briefing

***"Currently, FORCEnet is not on track. It needs to become more warrior centered, assume an enterprise-wide culture, and develop/apply metrics."*** **SSG-XXII, July 2004**

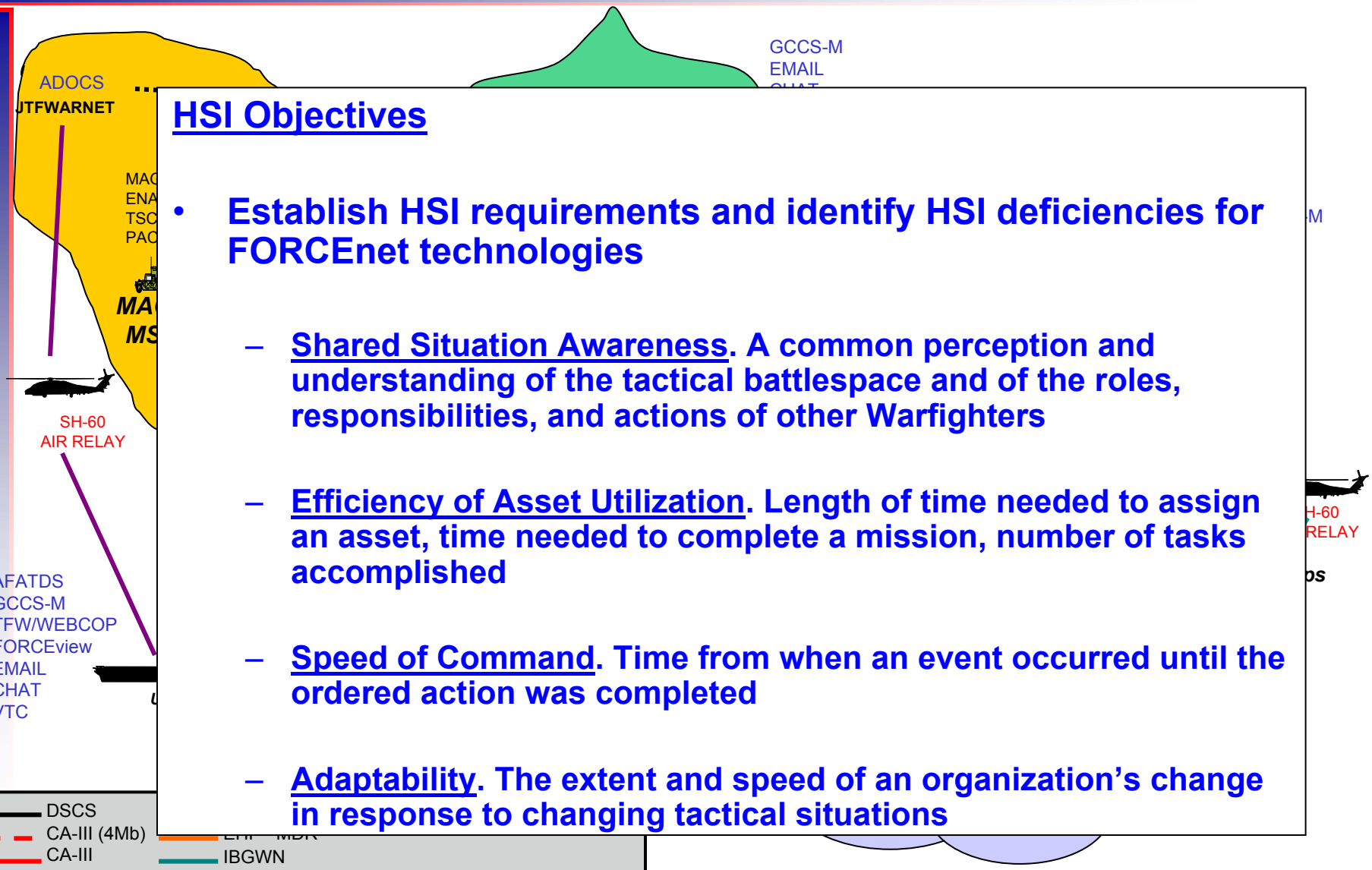
**"The real need (in FORCEnet) is to examine Decision Making, Cognition, and C2 - the human element. The current FORCEnet capabilities packages are too narrow ... The focus should be on increased speed of action, distributed forces, and goals… …need to examine the alignment of requirements, resources, and providers to create mutually reinforcing technological requirements**

- **Evaluate system of systems performance (an integration of factors and dimensions)**
- **Assess effective engagement and operations (human understanding, decision making, and C2) …"**

# FORCEnet Assessment Continuum



# Trident Warrior 03: A Initial Demonstration of NCW




## HSI Objectives

- **Establish HSI requirements and identify HSI deficiencies for FORCEnet technologies**
  - **Shared Situation Awareness. A common perception and understanding of the tactical battlespace and of the roles, responsibilities, and actions of other Warfighters**
  - **Efficiency of Asset Utilization. Length of time needed to assign an asset, time needed to complete a mission, number of tasks accomplished**
  - **Speed of Command. Time from when an event occurred until the ordered action was completed**
  - **Adaptability. The extent and speed of an organization's change in response to changing tactical situations**

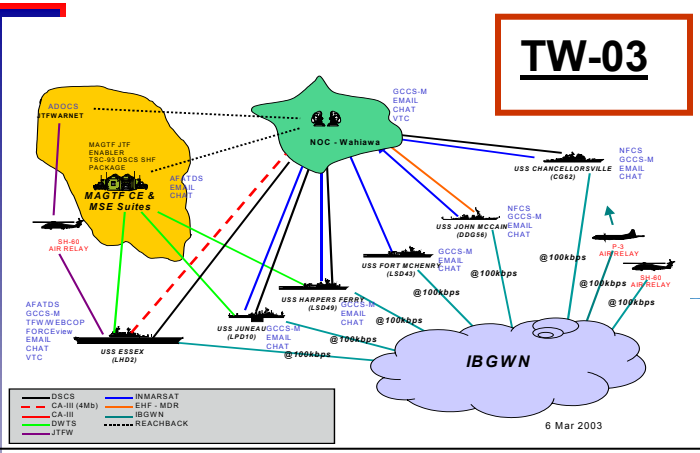
# HSI Measures

| | |
|---|---|
| **Performance** | Task Performance<br>Situation Awareness (SA)<br>Decision-Making (Speed of Command) |
| **Usability** | Ease of Use<br>Frequency and Context of Use<br>Scalability/Tailorability of Displays<br>Efficiency of Use<br>Effectiveness of Use<br>Error prevention and Handling<br>Visibility<br>Consistency/Familiarity of HCI<br>Satisfaction/Preference |
| **Information Transfer and Knowledge Management** | Ability to Share Information/Access Information<br>Quality of Information Exchanged during Collaboration Process<br>Shared Understanding of Missions, Roles, and Tasks<br>Efficiency of Information Exchange<br>Effectiveness of Information Exchange<br>Reliability/Credibility of Information |
| **Training** | Amount of Training Provided and Required<br>Value of Training<br>Proficiency<br>Documentation and Online Help |
| **Manpower and Personnel** | Manpower Required to Operate/Administer Systems<br>Availability<br>Match between Personnel and System Requirements |

# Major HSI Findings in TW 03

- Lack of a concept of operations for FORCEnet technologies; reduced shared situation awareness and ability to adapt to changing demands
- User interfaces need improvement: display configurations, workspace layouts, inefficiencies in how information was transferred within and between command centers; legibility of shared displays, and access to task-relevant information
- While training was provided on individual FORCEnet systems, no instruction was available on how to employ systems for maximal operational effectiveness resulting in operational inefficiencies
- Insufficient manpower available for new FORCEnet capabilities without removal of legacy systems

# Trident Warrior: Looking Forward




**TW-03**

- Expeditionary, multi-tiered weapon and sensor information (Call For Fires)
- Distributed, collaborative command and control (C2 / Collaboration)
- Dynamic, multi-path and survivable networks (Network Operations)

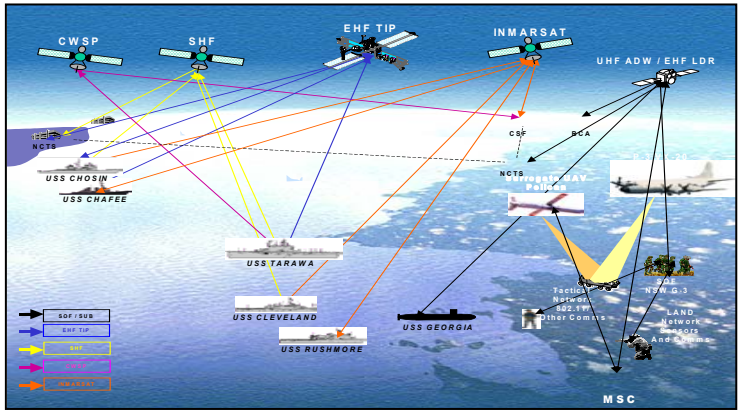
*HSI = "Come as you are"*

**TW-04**

- Networks
- Web-Enabled Warfighter
- Sea Warrior (Focus on Sailor career)
- ISR/fires

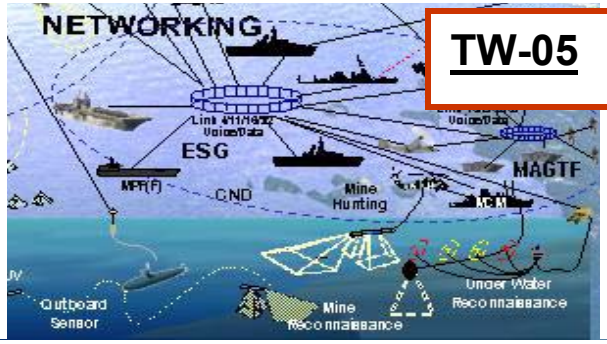
*HSI = Specific Objectives*

*Shared Situation Awareness, Speed to Command, Efficient Use of Warfighter*




*HSI = Real Opportunities*

- *Multi-Echelon*
- *Split Staff*
- *Shared SA of Intel Analysis*




**TW-05**

- Carrier Strike Group
- Coalition Networks
- Multi-Level Security Systems
- Inter-Force Wireless Networks
- Joint Distributed C2

# Model of Situation Awareness

*Recognition System*

*Analysis Process*

Event → External Sensors → Perception Sensory Register → Comparison With Memory → Decision Making → *Action*

MACHINE

HUMAN

*Outcome of Decision*

1 All data in the environment

2 Data detected by technological systems

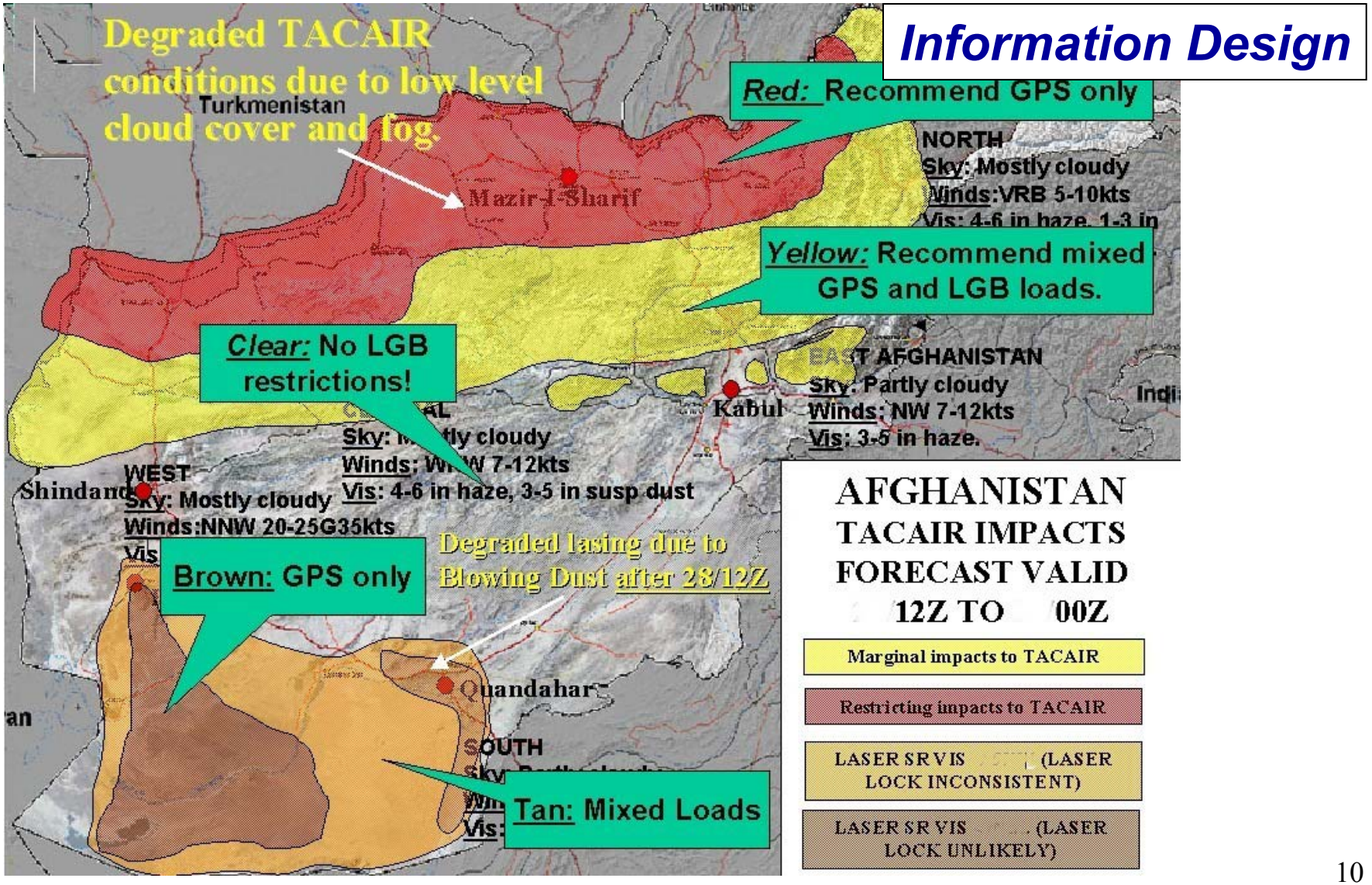
3 Data available on local C2 systems

4 Data perceived by decision maker

5 Comprehension of decision maker

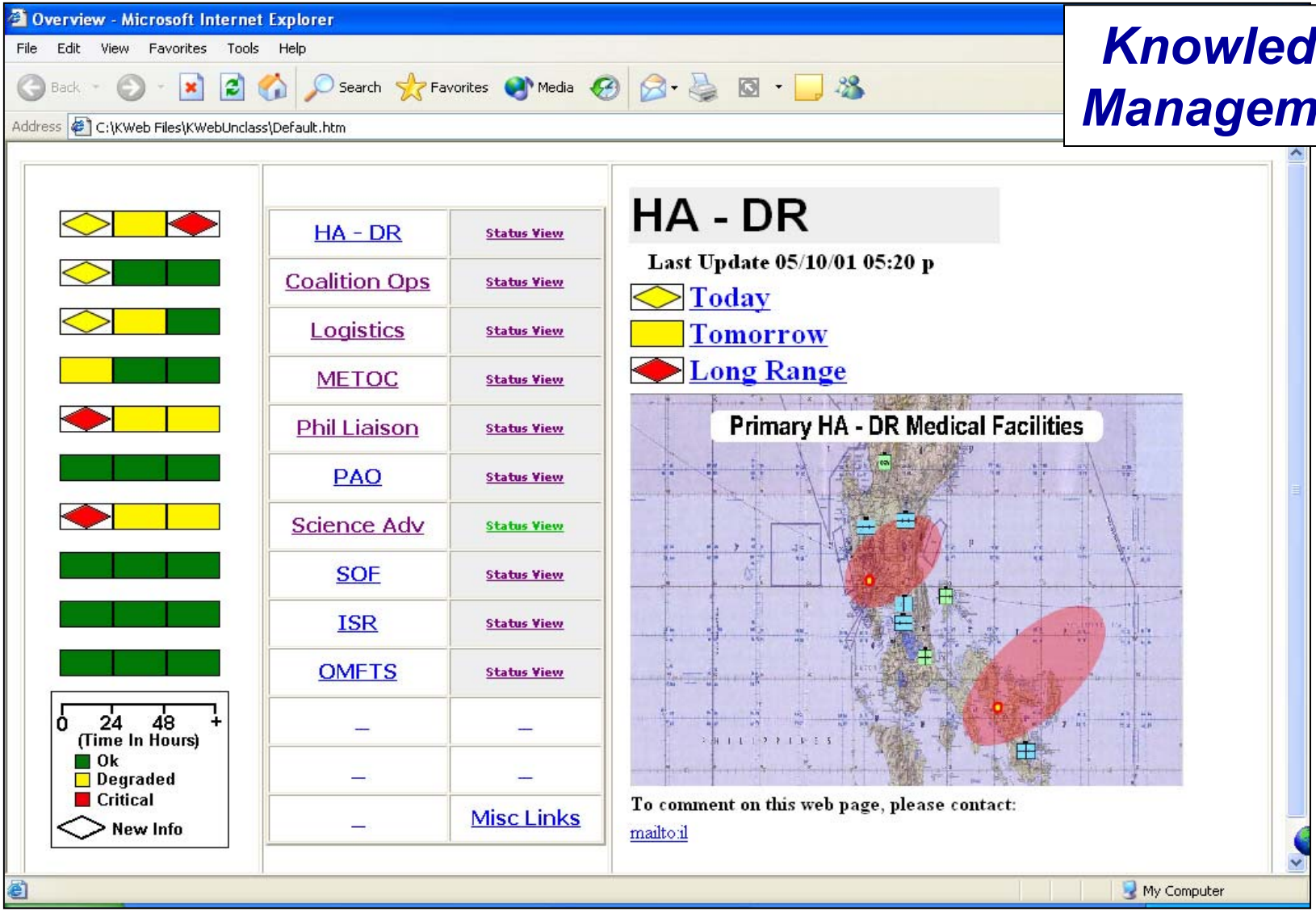
6 Projection of decision maker

# HSI – Data →Info→Knowledge (from CCG-3 Knowledge Web)



# HSI – Example K-Web Overview Page (shows status across mission areas)

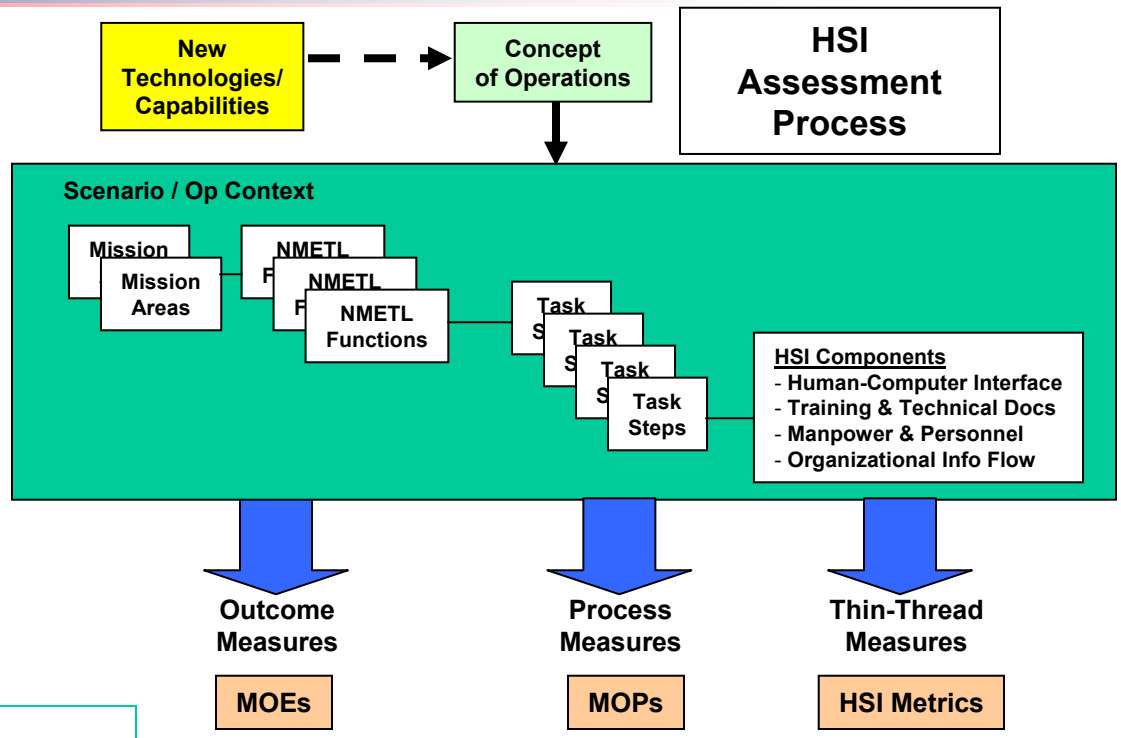
**Knowledge Management**



# Assessment Approach

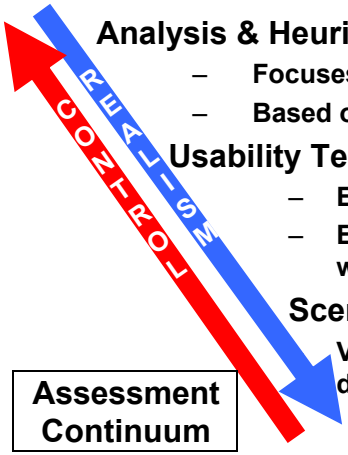
## CHALLENGES

- Functionality "between" stovepipes
  - Design
  - CONOPS
- Skills
  - Required level
  - Individual vs. Team
  - Training/Experience
- Workload
  - Cognitive and physical
  - Manpower
- Acquisition
  - Formal acquisition programs
  - Non-acquisition programs
- Human performance
  - Demonstrated improvements
  - Quantifiable measures




## APPROACH

- Integrated, multi-method assessment
  - Takes advantage of available assessment opportunities
- Linked with mission, tasks, and jobs
  - Extends ongoing MPT efforts in system acquisition
- Transferable across technologies
  - Easily expanded to incorporate future developments
- Addresses all facets of human performance in complex systems
  - Recognizes complex relationship between Technology, HF, MPT, etc.

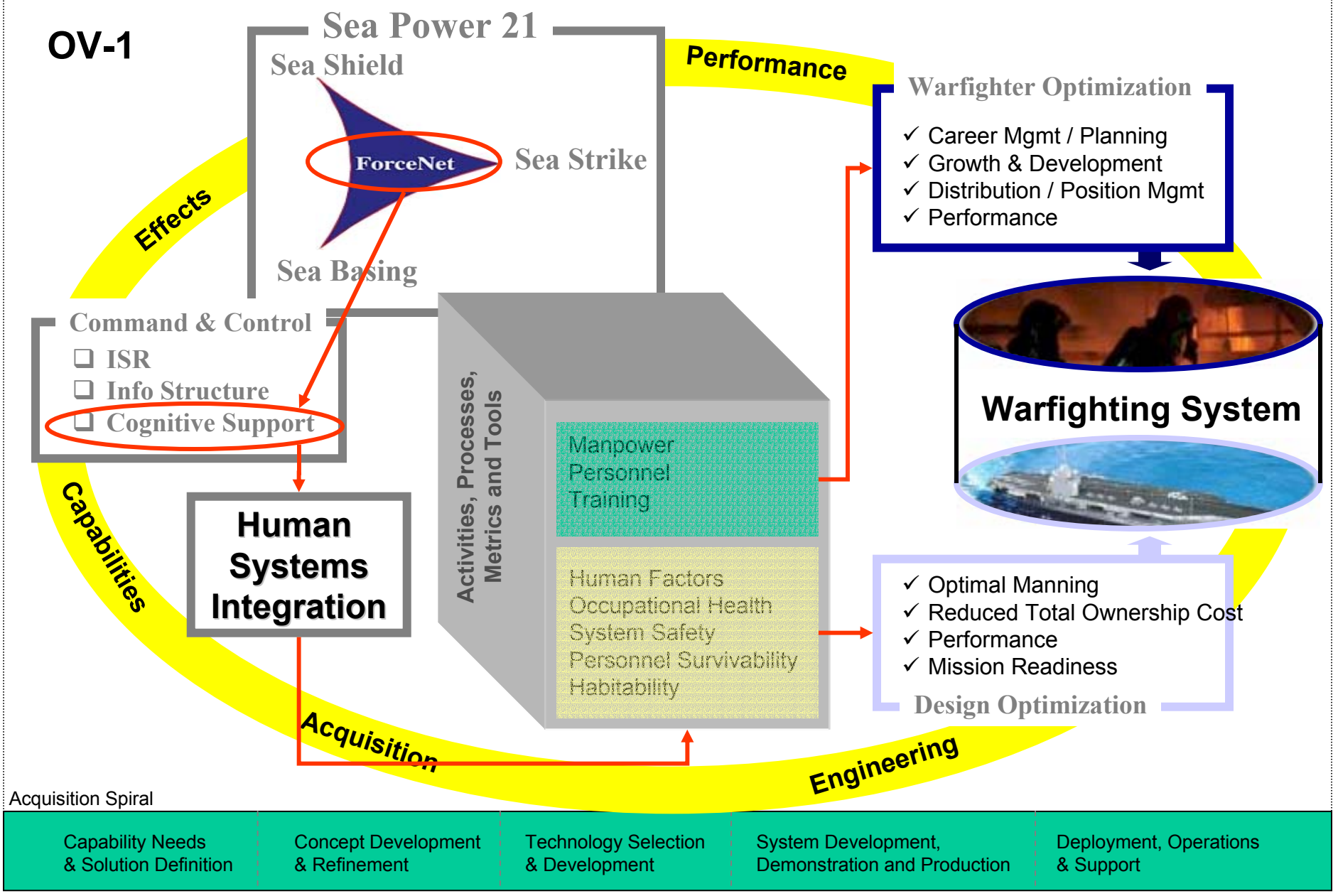


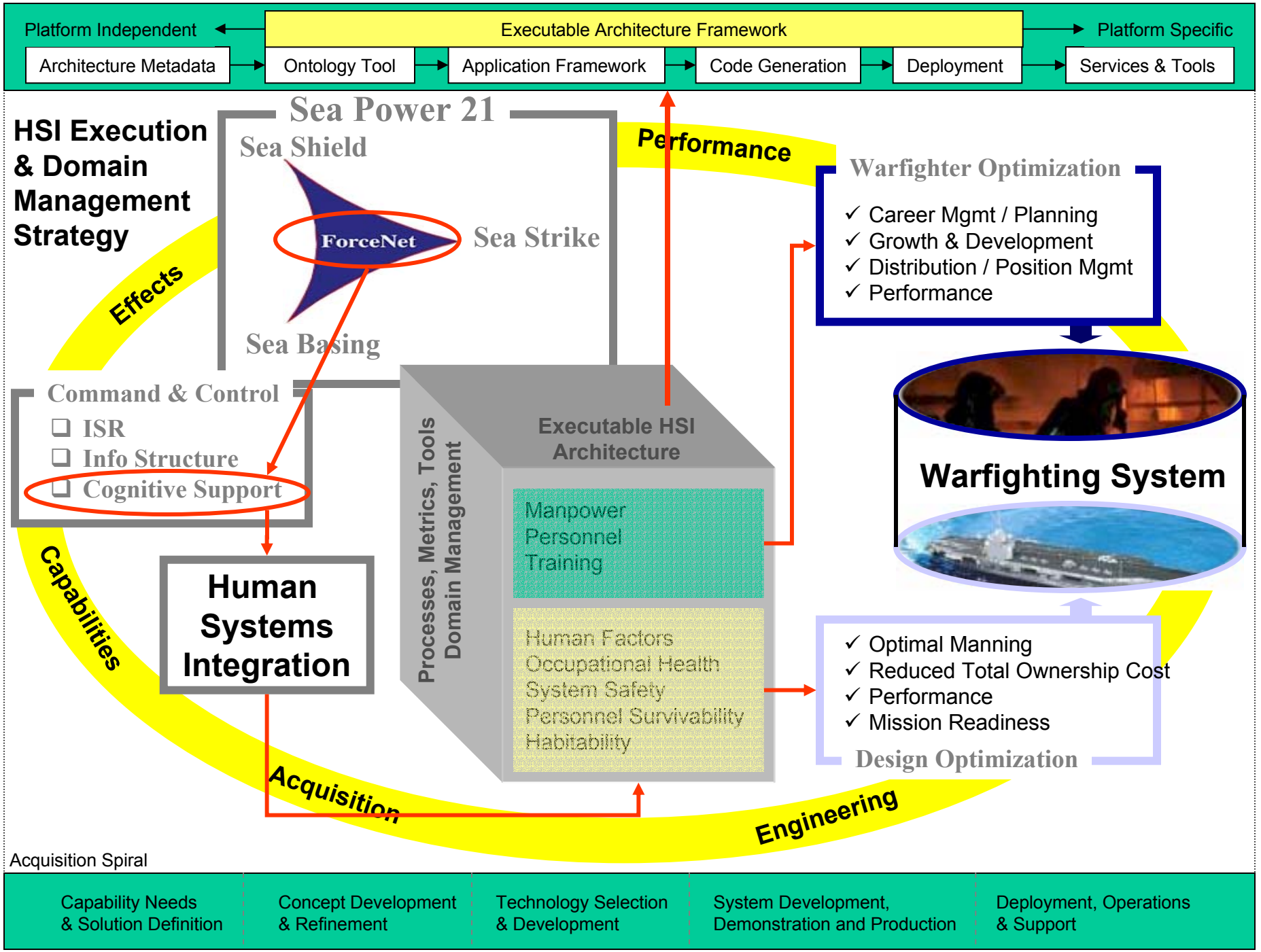

**Analysis & Heuristic Review**
- Focuses on technologies and system components
- Based on HSI standards and design guidelines

**Usability Tests & Limited Assessments**
- Examines technologies in simulated task context
- Empirical studies to get feedback from warfighters on utility, usability, reliability, etc.

**Scenario-based Exercises (IPD)**
- Verifies technologies' contribution to ME in dynamic, operational context
- Observation of global performance indicators

# Future Directions: HSI Enterprise Architecture




Platform Independent
Executable Architecture Framework
Platform Specific
Architecture Metadata
Ontology Tool
Application Framework
Code Generation
Deployment
Services & Tools
HSI Execution & Domain Management Strategy
Sea Power 21
Sea Shield
Sea Strike
Sea Basing
ForceNet
Performance
Effects
Warfighter Optimization
✓ Career Mgmt / Planning
✓ Growth & Development
✓ Distribution / Position Mgmt
✓ Performance
Command & Control
❑ ISR
❑ Info Structure
❑ Cognitive Support
Executable HSI Architecture
Processes, Metrics, Tools
Domain Management
Manpower
Personnel
Training
Human Factors
Occupational Health
System Safety
Personnel Survivability
Habitability
Warfighting System
Human Systems Integration
Capabilities
Acquisition
Engineering
✓ Optimal Manning
✓ Reduced Total Ownership Cost
✓ Performance
✓ Mission Readiness
Design Optimization
Acquisition Spiral
Capability Needs & Solution Definition
Concept Development & Refinement
Technology Selection & Development
System Development, Demonstration and Production
Deployment, Operations & Support

# Conclusions

- The Warfighter is a critical component of Network Centric Warfare (NCW)
- HSI Assessment in TW04 and other NCW events
  - Comprehensive HSI data collection and analysis
  - Comparisons to TW03 and other exercises to see trends
  - Aggregation across FORCEnet tests to determine HSI impacts
- Greater focus on development of TTP / ConOps
- Standard set of HSI measures and metrics
- Predictive analysis of HSI issues for new systems, design options, manning, training, etc.
- HSI Enterprise Architecture to structure HSI performance taxonomy and data repository


# Back-Up Slides

# FORCEnet Processes and Technologies

- **Call For Fires**
  - Automated Deep Operations Coordination System (ADOCS)
  - Advanced Field Artillery Tactical Data System (AFATDS)
  - Naval Fire Control System (NFCS)
- **Command and Control / Collaboration**
  - FORCEview
  - Global Command and Control System–Maritime (GCCS-M)
  - Task Force Web (TFW)
  - Web Common Operational Picture (WebCOP)
  - Collaboration Tools (Chat and MS NetMeeting)
- **Network Operations**
  - Automated Digital Network Switch (ADNS)
  - High Frequency Automatic Link Establishment (HF ALE)
  - Intra-Battle Group Wireless Network (IBGWN)
  - Super High Frequency / Commercial Wideband Satellite Program (SHF/CWSP)

# Call For Fires – 1

**Performance**

- Very limited shared SA among Flag Plot, SACC, and LFOC.
- SACC
  - Drawbacks: did not hold BDA on targets once the target was issued to a Fires resource. Flag Plot did not know about every target being taken until SACC asked for BDA.
- ADOCS: Supplies adequate amount of task-relevant information
  - Drawbacks: very slow when running other software, including C2PC.
- AFATDS: Works well if operator is well trained: maintains COP, deconflicts fires, and has good interoperability. Simplifies identification of force locations and status.
  - Drawbacks: a need to enter database and IP addresses and slow processing speed.
- NFCS: Presents information so it can be readily understood.

**User Interface**

- ADOCS: No specific usability problems were noted. Displays are easy to read.
- AFATDS: The better trained, frequent users rated AFATDS as very usable. Displays were easy to read, and information was presented logically.
  - Drawbacks: limited error prevention and detection, inconsistent color-coding, use of non-standard commands, and incomplete user feedback.

# Call For Fires – 2

## Information Transfer

- **Technical integration across systems for fires process worked very well.**
  - **Drawbacks: Problems observed in transferring information between SACC and ESG. Only way to exchange information between SACC, LFOC, and Flag Plot was via Chat.**
- **Time Sensitive Targeting messages were often sent directly from JIC to SACC.**
  - **Drawbacks: Flag Plot was not always aware of TST in progress.**
- **ADOCS: 2/3 of users felt that ADOCS did not enhance SA and did not help to identify force locations, understand status of users and equipment, and track tasking and scheduling.**
  - **Drawbacks: Problems noted in understanding status of other users and their equipment, estimating opposing forces capabilities, anticipating responses to Blue actions, identifying and resolving scheduling conflicts, time lag between SA and real events, and shared SA among team members.**
- **AFATDS: Supported SA and helped to identify force locations, understand status of users and equipment, and track tasking and scheduling.**
  - **Drawbacks: Potential SA problems noted in monitoring critical events; resolving scheduling and resource conflicts, and anticipating responses to blue actions.**
- **NFCS: Presents information so it can be readily understood.**

# Call For Fires – 3

**Training**

- A systems integration guide is needed to show how individual CFF technologies relate to each other from an operational (task) perspective.
- ADOCS: Training was described as inadequate. Procedures were not well understood and users wanted more training.
- AFATDS: More extensive formal training is needed. Users often did not understand AFATDS procedures or find job aids useful. The number of requests for technical assistance (to setup the system) was excessive.
- NFCS: More training needed to gain competence (4 hours training provided).

**Manpower/Personnel**

- Manpower was only one-deep for most CFF technologies.

# Command and Control/Collaboration – 1

**Performance**

- The Flag Plot watch team took 14 minutes to find the right format for an NBC-1 Report and 12 minutes to draft the message.
- The best SA was gained through the voice SITREPS.
- Chat:
  - Drawbacks: Multiple Chat tools caused confusion. Several users noted that monitoring several chat rooms increased their workload. Navy Enterprise Portal helps to consolidate chat rooms, but does not work with all chat programs.
- GCCS-M: Frequent users can reduce the time needed to organize information and decide what actions to take.
- NetMeeting:
  - Drawbacks: Requires a lot of bandwidth. Consistent availability is an issue. Whiteboard slowed system down too much, creating unacceptable time lags. The 10 user limit was a serious shortcoming. File transfers were rated disorganized and ineffective.
- WebCOP: Worked well; used for briefs in Flag Plot.
  - Drawbacks: Occasionally, COP was lacking: (a) COP in Flag Plot was did not match COP on the Chancellorsville; and (b) specific objects could not be located or their map locations were inaccurate.

# Command and Control/Collaboration – 2

**User Interface**

- **Ergonomic deficiencies in the Flag Plot workspace:**
  - **High traffic and noise levels hindered task performance and development of SA.**
  - **Traffic flow intermittently blocked view of large screen displays at front of Flag Plot.**
  - **Legibility of text on large screen displays at front of Flag Plot was poor for observers seated in the back of Flag Plot.**
  - **Locations of some displays produced difficult viewing angles.**
- **Technical incompatibilities among the different Chat systems.**
- **Flag spaces need larger displays for watch-standers.**
  - **Multiple-screen console (e.g., Multi-Modal Watch Station or Knowledge Desk) would be helpful.**
- **Chat: Good screen legibility, information presentation, and navigation.**
  - **Drawbacks: (a) inadequate feedback, (b) poor error prevention and recovery, (c) difficulties in gaining SA without viewing entire chat sequence (scrolling issues), (d) limited formatting capabilities, and (e) pressing the Enter key inadvertently sends Chat message. MS Chat deficiencies included no authentication, no time stamp, and no auto logging.**
- **GCCS-M:**
  - **Drawbacks: non-standard and/or inconsistent icons, menus, buttons, navigation, operating procedures, and commands. Large amount of information clutters its display. Inadequate error prevention and recovery.**
- **NetMeeting:**
  - **Drawbacks: information presentation, navigation, and error detection and recovery. A single user was required to participate in different chat rooms to talk to different**

# Command and Control/Collaboration – 3

**Information Transfer**

- Much 'sneaker net' occurred between key watch standers in the JIC and LFOC going to and from the Flag Plot.
- Chat: Chat generally reduced time and effort needed to identify users, exchange information, and support coordination among users.
  - Drawbacks: Confusion occurred when orders sent via Chat were not acknowledged. Timely messages dependent on typing skills of sender. BWC had to approve all chat dialogue before it was sent.
- GCCS-M: Generally, simplified identifying force locations.
  - Drawbacks: SA problems: (a) Keeping track of tasking, scheduling, and critical events; (b) Identifying scheduling and resource conflicts; (c) Tracking progress toward objectives, and (d) Anticipating responses to blue actions. Some users felt their SA lagged significantly behind actual events. (Catastrophic effect if GCCS is used to provide track information for fire support systems.)
- WebCOP: Kept track of mission goals and objectives, critical events, and goals and actions.
  - Drawbacks: SA ratings were moderately negative.

# Command and Control/Collaboration – 4

**Training**

- Crew was mostly unaware of capabilities of Fn technologies.
- A new concept of operations, and staff familiarity with it, is needed within the ESG to promote effective collaboration using the Fn technologies.
- The tempo of operations in Flag Plot was very high, due in part to confusion over the use of the new C2 Fn technologies.
- Lack of standardized message posting procedures on the ESG web site complicated finding information.
- Chat: Most users reported no formal training on Chat, but only 3 wanted additional training.
- GCCS-M:
  - Drawbacks: Many users did not understand its procedures, felt inadequately trained, and that documentation and online help needed improvement.
- NetMeeting: Most felt they had received adequate training, with half reporting that documentation and online help were all the training needed.
- Task Force Web:
  - Drawbacks: All users felt they had not received adequate training and that the online help was not sufficient training by itself.

**Manpower/Personnel**

- Chat:
  - Drawbacks: More simultaneous chat rooms were in use than could be effectively monitored and serviced by the assigned staff.
- GCCS-M, NetMeeting: The number of calls for technical assistance was

# Network Operations

**Performance**

- ADNS: Stable; no trouble calls reported during TW03.
- HF ALE: The Marines' HF ALE radios do both voice and data.
  - Drawback: Shipboard radios could not handle data, voice only.
- SHF/CWSP:
  - Drawbacks: SHF was difficult for the operators/administrators to manage. If the hardware is powered down, all configuration settings are lost, requiring increased workload to reconfigure.

**User Interface**

- IBGWN:
  - Drawbacks: Very complex, non-intuitive interface. When switching between configuration displays, different screens would contradict each other for established connections.

**Training**

- Network Systems:
  - Drawbacks: Training for the new network technologies was marginal. Training for most of the new technologies was left to the individual ships and groups. ITs were not given training on the Network Operations system as a whole. Single technology expertise is inadequate since network technologies are becoming highly interrelated.
- IBGWN:
  - Drawbacks: No technical representatives available during TW03 for training or information.

**Manpower/Personnel**

# MOE Summary

| HSI Process | Measure of Effectiveness | | | | |
|---|---|---|---|---|---|
| | Performance | User Interface | Information Transfer | Training | Manpower& Personnel |
| Call For Fires | G | G | Y | Y | Y |
| C2 / Collaboration | Y | Y | Y | Y | G |
| Network Operations | G | | | Y | |

- G Fully functional. Meets requirements but can be improved with minor modifications.
- Y Functional but requires substantial modifications.
- R Largely non-functional and needs major modifications.
- Inadequate data were available for valid assessment.

# MOEs, MOPs, and Metrics Examples

## MOE: Performance

- **MOPs**
  - **Task Performance: Extent of support for required tasks**
    - **Metrics:**
      - **Extent of usage of tool/application to support task**
      - **User rating of usefulness of tool to support task**
      - **User rating of task efficiency – timeliness to complete task**
      - **Observer, SME, or superior rating of task efficiency – timeliness to complete task**
      - **User rating of task effectiveness/quality – task accuracy**
      - **Observer, SME, or superior rating of effectiveness/quality – task accuracy**
      - **User rating of workload associated with performing task**
  - **Situation Awareness (SA): Understanding of relevant aspects of operational situation, relationship between these with each other and evolving situation, and how the situation and events will unfold in the future**
    - **Metrics:**
      - **Accuracy and timeliness of answers to questions embedded in scenario communications**
      - **Accuracy of answers to questions at "stopping points" of scenario**
  - **Decision-making: Availability and extent of use of tools to support decision-making; timeliness and accuracy of decision making (Speed of Command)**
    - **Metrics:**
      - **Availability of tools/application to support decision-making**
      - **Use of tool/application to support decision-making**
      - **Observer, SME, or superior rating of accuracy and timeliness of decisions**

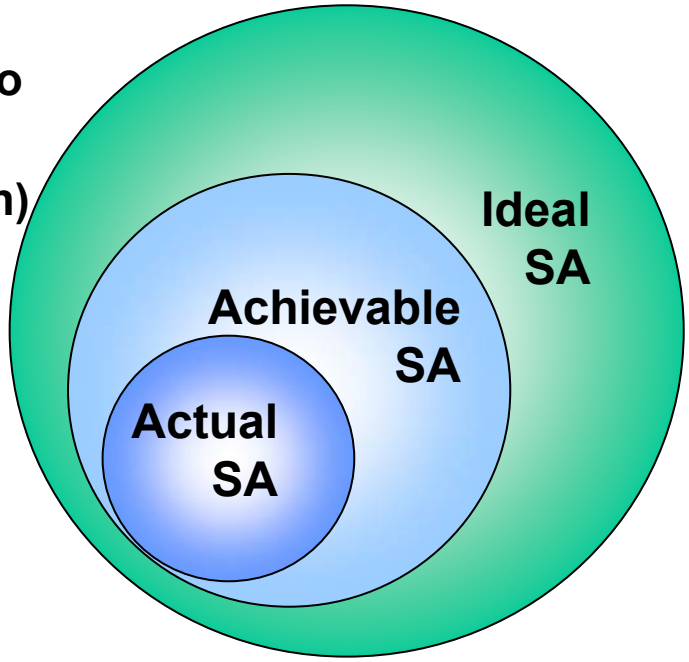
# Major HSI Findings in TW 03

- Loss of SA
  - Displays did not support Flag Plot functions
  - Poor workspace layout (screen real estate)
  - No standardization/no functional analysis on decision making process
    - Unclear where to find or post info
    - Many websites/portals/chatrooms to monitor
- Impaired Speed of Command
  - 26 minutes for NBC report
  - 8 minutes to assess hostile intent of track
- Information Exchange Shortcomings
  - Chat used to pass orders; not always acknowledged
- Little or no system integration training provided for new Fn systems
- Manpower analysis for new Fn systems not addressed; legacy systems remain

***Insufficiently developed concept of operations for integrating Fn technologies with current information transfer procedures. Warfighter unable to fully understand how to employ Fn capabilities.***

# Situation Awareness

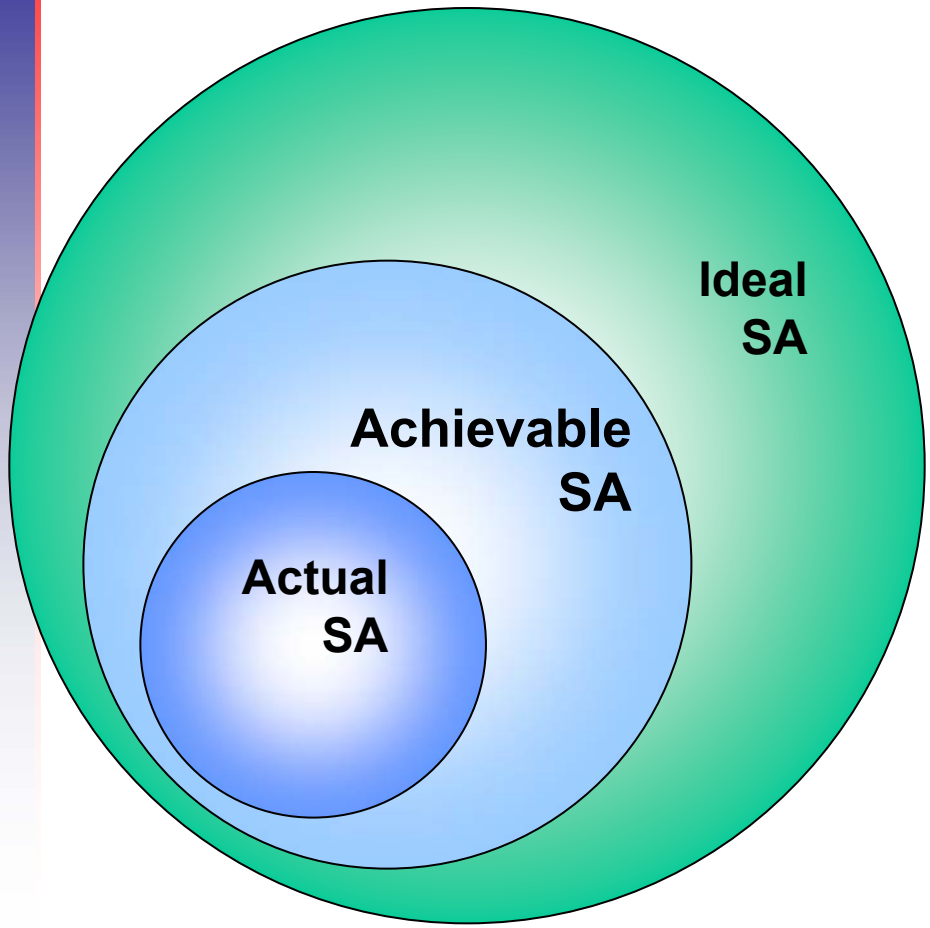
- **Situation Awareness**
  - Assembling information across multiple agents over extended time … asynchronous, distributed environment
  - Piece together scraps to form likely scenario or course of action
  - Ensure a shared perspective (and projection)
- **Ideal SA:** The information and knowledge requirements defined by experts*
- **Achievable SA:** the subset of Ideal SA available to the decision makers*
- **Actual SA:** The subset of Achievable SA inferred from measurement or observation*




**Pew, 2000*
*Situation Awareness (SA) is*
*(1) the perception of elements in the environment within a volume of time and space,*
*(2) the comprehension of their meaning, and*
*(3) their status in the near future."* *(Endsley, 1988)*

# UNDERSTANDING SA

## Situation Awareness (According to Pew (2000))




Ideal SA: The information and knowledge requirements defined by experts, often after the fact.

Achievable SA: The subset of ideal SA that is available to the decision makers.

Actual SA: Inferred from measurement or observation and is a subset of achievable SA.